Smart Plastics

Schedule:

Week 1: Historical overview, concepts, and definitions of intelligent materials and intelligent polymers. Classification and general characteristics of "intelligent" materials. Historical development.

Week 2: Polymer physics and polymer chemistry basis of "intelligent" functions (shape memory, self-healing, multifunctionality): the role of molecular structure, glass transition temperature (Tg), melting point (Tm), relaxation processes, and cross-linking in the development of intelligent behavior.

Week 3: Color-changing intelligent plastics. Structure of thermochromic and photochromic polymers. Light absorption and emission properties of chromophore groups. Durability and stability issues in polymers containing chromophore groups.

Week 4: Thermally activated and temperature-responsive polymers: LCST/UCST-type polymers. Thermoresponsive gels, macromolecular networks and composites. Temperature-activated shape-memory mechanisms.

Week 5: Shape memory polymers (SMPs) and elastomers: single- and multilayer SMP systems: programming and recovery cycles. Mechanical properties of thermally activated polymers.

Week 6: Self-healing polymers and polymer composites. Microcapsule-based self-healing systems. Self-repairing polymers based on hydrogen bonding, dynamic covalent bonds, and supramolecular networks.

Week 7: Magnetic and electromagnetically controllable smart polymers. Polymer composites containing magnetic nanoparticles. Shape and property changes induced by magnetic fields.

Week 8: Light-activated polymers, photonic and optical intelligent systems. Light-induced conformational changes (azobenzene groups, photopolymerization chains). UV–VIS-activated mechanical and/or chemical transformations, light-driven actuators and smart coatings.

Week 9: Chemically activated polymers: pH-, ion-, and redox-sensitive polymers. Functioning of hydrogel-based intelligent systems. Drug delivery solutions: controlled and targeted release.

Week 10: Intelligent polymer composites and nanocomposites: functional polymers reinforced with nanoparticles (e.g., graphene, CNT, nanocellulose). Effect of morphological control (layer structure, orientation, phase separation) on smart behavior.

Week 11: Processing and manufacturing technologies of intelligent plastics: 3D printing (FDM, SLA) with intelligent polymers; challenges in extrusion and injection molding of stimulus-responsive systems. Additives and their effects on intelligent functions.

Week 12: Application possibilities of intelligent materials; the role of intelligent polymers in Industry 4.0; sustainability challenges: recyclability and environmentally friendly properties.